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TIS—A Focal Point for Technology Transfer

V. E. Hampel, J. B. Cain,
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September 1982

Lawrence Livermore National Laboratory

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Contents

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COPY
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2

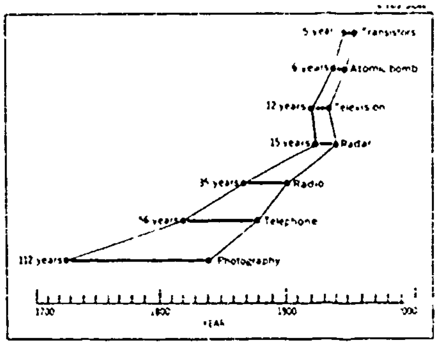
TIS — A Focal Point for Technology Transfer

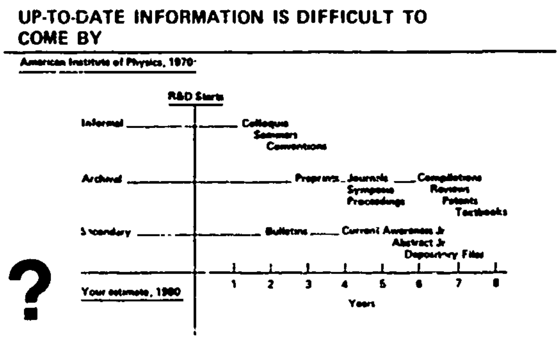
Summary

Lawrence Livermore National Laboratory (LLNL) is using the Technology Information System (TIS) to establish a focal point for technology transfer in support of its Office of Research and Technology Applications (LLNL/ORTA). The program was started earlier this year in compliance with the Stevenson-Wydler Technology Innovation Act of 1980 (PL-96-480) and with corresponding Department of Energy (DOE) Order 5800.1. TIS is slated to become the computer-based reference point for the identification of LLNL programs available for transfer to the public domain, as well as an effective means for communicating with the respective offices of other federal agencies: the Federal Laboratory Consortium (FLC), the Technology Transfer Society (T^2), the NASA Industrial Applications Centers, and a selected number of state and local offices. Available resources include the online International Technology Transfer Dictionary of more than 2000 experts in the field, the TECTRA newsletter and technology databases maintained by the School of Business and Public Administration at the California State University in Sacramento, the patent database to more than 2000 DOE patents potentially available for licensing, and a growing number of federal information centers, such as DOE/RECON, DOD/DROLS, DOL/SEEDIS, NASA/RECON, and CIS. TIS is used for the creation, report generation, and graphic display of descriptive and numeric data files, the execution of interactive models calculating the performance of electric vehicles, electronic mail, interconnection to electronic word processors and typesetters, and nationwide networking. The system is fully self-guided, which also permits those without computer experience to search, extract, and post-process relevant information in a productive and timely manner. This type of analysis can be used to identify the status and direction of ongoing government-supported research and development (R&D) and to increase industrial productivity by technology transfer.

1. Introduction

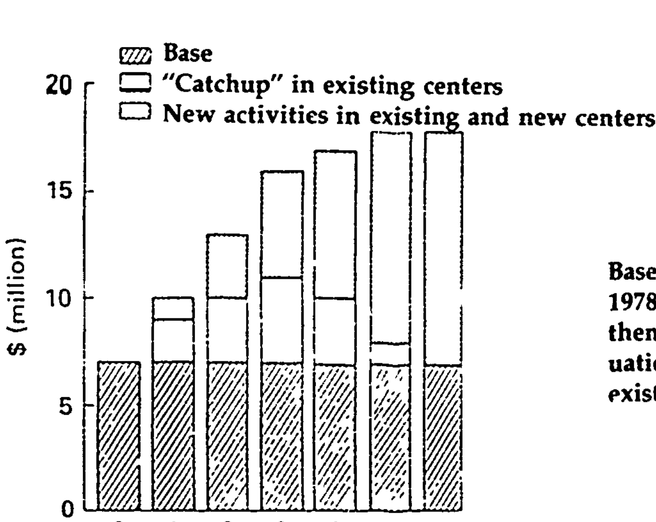
Successful transfer of adv..nced technology to industry is the main purpose of government-supported, high-risk R&D. However, the time delay between discovery and application, as estimated by *Science* and the American Institute of Physics, is four to seven years:





This delay has decreased little during the past decau., and much has been written about how to improve it and to inci ease national productivity.

Equally significant is the absence of a national plan in the United States for the evaluation and organization of numeric data and material properties. Countries less able to pay for the expensive instrumentation and apparatus needed for innovative research in science and technology are harvesting the results of our government-support R&D work while we, the contributors of nearly 60% of the world's technical literature, oblige our researchers to read preceding publications time and time again, to make their own evaluations, or to buy compiled and evaluated data from commercial vendors, a growing number of whom are based abroad. Although this dilemma was pointed out in 1978 by the Numerical Data Advisory Board of the National Academy of Sciences (NAS/NDAB)[1], direct support for the evaluation of material properties by federal agencies to the Office of Standard Reference Data, National Bureau of Standards, has remained embarassingly small.



Base level of funding estimated to prevail in 1978, the funds required to catch up with the then-existing two- to five-year b..cklog of evaluations, and recommendations for new work in existing and new centers.

2. Technology Transfer Programs

The main problem faced by a technologist in R&D remains the same: how best to find and use transferable technologies in a timely manner. For some time, disparate efforts have been ongoing in the United States. Although these efforts are to be united under the Stevenson–Wydler Technology Innovation Act. unification is difficult because of the differing natures of the efforts, some of which are not computer-based. The Technology Information System (TIS) at the Lawrence Livermore National Laboratory (LLNL), discussed later in this report, provides capabilities by which such geographically distributed and disparate transfer efforts can be used to establish an integrated resource for the access, searching, and dissemination of available technologies. In addition, TIS can provide effective means for electronic communication among liaison offices of the national technology transfer programs.

2.1 Stevenson-Wydler Technology Innovation Act of 1980

To improve the situation, Congress mandated that federal agencies make technology transfer an integral part of their ongoing R&D work. Public Law 96-480 formalizes the implementation and reporting requirements expected of federal agencies. It builds on previous less formal and separate programs that include the traditional centers of federal agencies, the activities of the Federal Laboratory Consortium (FLC), the Technology Transfer (T^2) society, and the Interagency Information Exchange (IIE) group and establishes, at the national laboratories, new offices dedicated, on the working level, to technology transfer. The intent of PL-96-480 is, therefore, to make technology transfer a regular part of the federal R&D effort, which is expected to accelerate the diffusion of tax-supported innovative work. Specifically, the law requires each federal laboratory to:

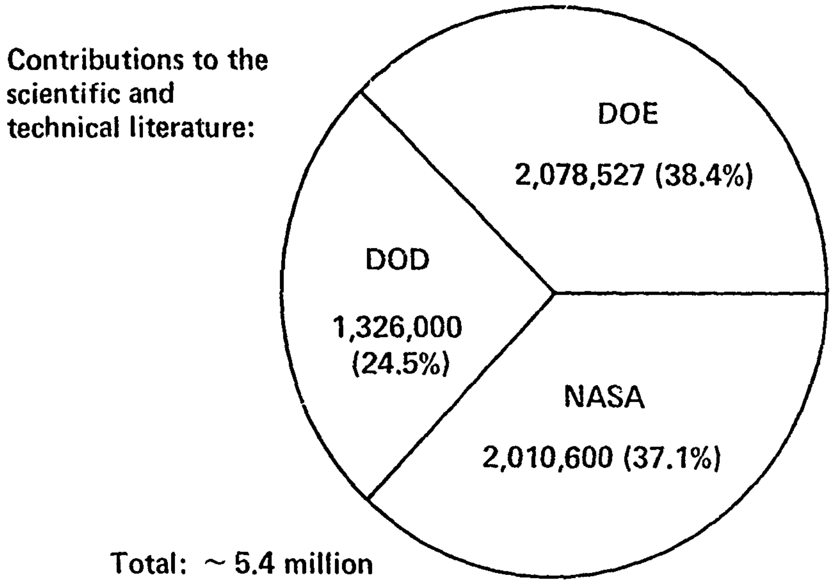
1. Establish an Office of Research and Technology Applications to work with potential users.
2. Formally assess laboratory R&D projects determined to have potential for successful applications beyond the project.
3. Disseminate information on products, processes, and services.
4. Cooperate with Department of Commerce transfer and commercialization programs, the FLC, and other technology transfer organizations.
5. As appropriate, provide technical assistance for applications.

The execution of these required functions is expected to be integrated into R&D activity at agencies and laboratories. This implies that the results of R&D are to be reported not only to the public domain via the respective existing information centers of each agency and the National Technical Information Service (NTIS), but are to be highlighted as being ready and available for transfer in succinct documents and files of each national laboratory. Knowledgeable staff members will act as contacts and liaison for inquiries from other agencies, universities, industry, and the general public. Before we discuss the ongoing activities at LLNL, however, it is pertinent to review the background and status of technical reporting and dissemination.

2.2 Technical Information Centers

Federal agencies instituted the collection, indexing, and dissemination of their R&D results decades ago. The largest centers reporting on work in science and technology are those of the Department of Energy (DOE/TIC). the National Aeronautics and Space Administration (NASA/S&R), and the Department of Defense (DOD/DTIC). Most of their files are bibliographic directories that point to publications in the public domain and are released as laboratory reports and as articles in the journals of professional societies. Jointly, these three agencies sponsor and report the results of the largest investments in science and technology. Their relatives contributions are:

DOE, DOD, and NASA Create and Maintain the Largest Body of Technical Information



These large collections of bibliographic databases are available online for interactive searching with computer terminals, via telephone dial-up, and are used by agency administrators, their contractors, and other federal agencies. The systems are known respectively as DOE/RECON,[2] NASA/RECON,[3], and DOD/DROLS.[4] Copies of the major, unclassified databases of these systems are being released periodically to commercial information vendors who offer them for searching to the general public. Full-text copies of relevant reports can be ordered at cost from the National Technical Information Service (NTIS).[5] Recently, several federal information centers have established special databases that highlight the availability of topical technologies or patents.

However, these federal and commercial information centers are stand-alone systems, obliging a qualified user to establish individual contracts and to use them on a one-to-one basis. This requires knowledge of system-dependent log-on procedures, telephone numbers, identifications, passwords, and protocols. Since most of these systems have developed independently, the user must also be familiar with different command languages. Bibliographic citations identified on any one of these systems are usually viewed on the screen of a computer terminal, or are printed online. Large volumes of retrospective citations are printed offline at the remote information center and are sent to the account holder by postal mail.

The use of these information resources is tedious. The user has to eliminate the unavoidable overlap of bibliographic citations and manually inspect, organize, and appraise the value of the retrieved results. Nevertheless, these technical information centers perform a vital function and represent the largest effort in technology transfer to date.

2.3 NASA Industrial Application Centers

NASA established a highly successful technology transfer program in the 1960s through the NASA Industrial Application Centers. Ten such centers are now funded in part by NASA, by the host installation, by federal programs like the Small Business Administration, and by recipients of the technology itself, e.g., industry. One of these centers is COSMIC, the computer software transfer center at the University of Georgia. The others are strategically located throughout the country, servicing seven regions and two states.

This technology transfer program is a direct result of the Space Act of 1958, which required NASA to "provide the widest practicable and appropriate dissemination of information of its activities and results thereof." NASA's mission, and therefore NIAC's, is to transfer technological information, as a spinoff of the space program, to the private sector for reuse and reapplication.

The transfer of information is carried out through online searches of computer-based federal and commercial databases, augmented by experts at the host installations, and NASA field offices. Input to their databases is indexed from journal articles, books, newspaper stories, and government reports. The databases cover domestic and international sources on a wide range of topics, including applied science and engineering, the physical sciences, business, life science, and patents.

NIACs provide specified customized database searches that take into account the qualifications of the client (e.g., range of dates, journals to be covered, authors, and cost). Searches may be ordered by telephone or by mail. The NIAC staff strives to respond within 48 hours.

Until now, searching has been done by conventional means through telephone dial-up of individual commercial and federal information centers. Succinct results from the different sources are printed online or, in the case of retrospective searches, are mailed as computer printouts by the information center. When the results do not meet the requestor's needs, the search must be repeated. This process increases user costs and may require several weeks, at which time some dated searches may no longer be relevant

To improve this situation, the automated access and post-processing capabilities of the LLNL Technology Information System (TIS) were tested by the NIAC center at the University of Southern California. Their procedures and results are described later in this report.

2.4 Federal Laboratory Consortium (FLC)

A laboratory consortium for technology transfer was formally begun in 1971 to facilitate the effective use of new products and services derived from research sponsored by the Department of Defense. At that time, the National Science Foundation established a technology transfer liaison service to promote communication between DOD laboratories and other agencies. The resulting DOD Consortium was established to improve laboratory communication and to expand the secondary utilization of laboratory-developed technology. Because of the interest in technology transfer expressed by other federal laboratories, the DOD Consortium was enlarged in 1974 to a federal laboratory consortium, and the FLC was established. Membership in the FLC is open to all federal laboratories. Today, the FLC has a current membership of over 200 R&D laboratories and centers from 11 federal agencies.[7] This growth in membership indicates how interested the laboratories and their agencies are in maximizing opportunities for new applications of innovative R&D.

2.5 Technology Transfer (T^2) Society

The T^2 Society was incorporated in 1975.[8] The founders felt there was a need for a nonprofit international organization that could act as a catalyst for accelerating the movement of technology to its ultimate application.

The Society has grown steadily, attracting professionals across the U.S. and in foreign countries. Its membership includes individuals from industry, government, research, and education who are concerned with issues of technology transfer, utilization, assessment, and forecasting. The Society publishes a newsletter and conducts an annual international conference. Together with other societies, it has also cosponsored a number of seminars on advanced technology. The *Journal of Technology Transfer*, a peer journal for the presentation of papers describing experiences, processes, methods, views, and research findings is sent free to all members. A library on the transfer, utilization, assessment, and forecasting of technology is operated at the Society's headquarters in Los Angeles. It is the repository for all information generated by the Society and its members.

The Society is empowered to enter into contracts for studies and other work related to its mission. The Productivity Improvement Council, created by the Society to address the growing national problem of declining productivity, is an example of such work. The Society is a nonprofit organization. Activities of the Society are supported by individual members and corporate dues.

2.6 Interagency Information Exchange (IIE) Group

This recent effort to promote the sharing of advanced information technology among agencies was reconstituted in the spring of 1980. The Group, which consists of 1 to 2 representatives from 17 federal agencies and organizations, was organized to encourage the use of information sytems that have government-wide applicability and to facilitate the development of applications that have significant utility across departmental and agency lines.

The need for such a group was identified dramatically in the *Federal Data Processing Reorganization Report* (FDR). The thrust of the recommendations called for the establishment of a strong focal point within the Executive Branch that would "encourage and facilitate" the interchange and interagency utilization of common, beneficial applications, as well as provide a positive force for the introduction of new and advanced information technology in the federal government.[9]

The IIE recognized in particular the difficulty of accessing and utilizing *available* information resources. To solve the problem of dealing with the variety of information systems, incompatible computer resources, and complex and different access procedures, the Group selected, in 1980, the TIS at LLNL for its electronic mail communications among group members and for automated exploratory networking with federal information centers. Of particular interest to the IIE are the TIS transparent access procedures and post-processing techniques for text and data.

2.7 Department of Energy Implementation of PL-96-480

The Department of Energy implemented PL-96-480 by DOE Order 5800.1, issued by William S. Heffelfinger, Assistant Secretary for Management and Administration, March 25, 1982. The nature and policy of the Order are:

- The laboratory's explicit technology transfer activity will be funded from overhead.
- The laboratory's explicit technology transfer activity will be placed organizationally so as to have labwide support and effective access to all program activity.
- The laboratory will include a five-year technology transfer plan as part of the institutional plan, showing level of effort and scope of activity.
- The laboratory will prepare an annual report describing significant technology transfer achievements over the previous fiscal year.

The law mandates at least 0.5% of agency R&D funding for technology transfer. Each agency and laboratory has implicit programs that comply in part with this mandate. However, the establishment of explicit local offices at the laboratories to interact with the ongoing programs and act as catalysts for the technology transfer process is new.

2.8 LLNL Office of Research and Technology Applications (ORTA)

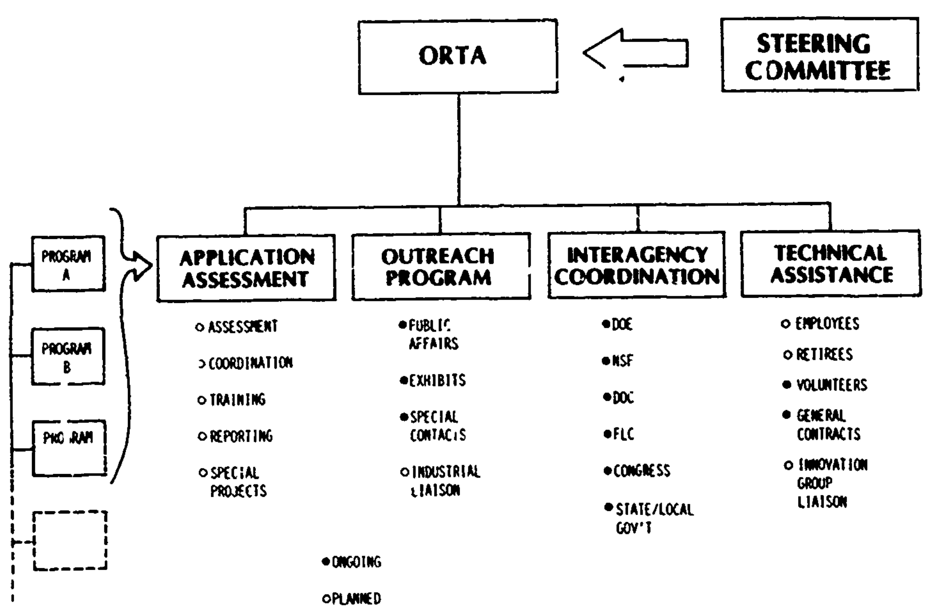
The LLNL/ORTA office was established in 1981.[10] Both PL-96-480 and Order 5800.1 clarified a number of the technology transfer policies that varied greatly among individual laboratories and provided specific guidelines for implementation. The ORTA office at LLNL is a part of the Laboratory's mission. Its goals and objectives are:

- To provide maximum benefit to LLNL programs, consistent with the intent of the law.
- To document and plan present work to demonstrate that much of it qualifies as technology transfer.
- To structure activities so that program offices have the dominant role in technology transfer.
- To coordinate and support technology transfer through the ORTA, not by control of program activity.
- To make maximum use of contract personnel for specialized jobs not generally needed by the Laboratory.

The above objectives are interrelated and can be viewed as an ongoing process linking the activities of several LLNL programs. The LLNL/ORTA is charged with administering these efforts and with stimulating and fostering an awareness throughout the Laboratory of both its obligation and the benefits of technology transfer. Recipients of the technologies transferred include firms in the industrial and commercial sectors, state and local governments, and related institutions and entities.

One of the activities, application assessment, is the task of evaluating the potential of all R&D projects and searching for new and secondary uses. Program personnel are asked to make the initial selection of specific transfer candidates. Final selection will be made by a technical committee under ORTA staff supervision. Technical assistance will generally be provided at no cost to local governments. Direct expenses for technology assistance will normally be paid by industry. A technical steering committee is helping the ORTA implement the LLNL technology transfer program.

LLNL Technology Transfer Program



3. TIS Technology Information System

The mandated objectives of technology transfer require timely identification, reliable assessment, and effective communication of R&D results among agencies, members of the FLC, the T^2 Society, and local laboratory offices.

The operational capabilities of the TIS meet these requirements and permit the creation of a unified view of available resources for the technologist. Unlike other information systems, TIS gives authorized viewers direct automated access to geographically distributed information centers, as well as permitting them to extract, aggregate, and analyze descriptive and numeric data in an interactive, self-guided manner and to quickly transfer the desired results to the end-user. Moreover, requestors can link their terminals to those of information specialists and, from their offices or homes, watch the progress of a search on their own video screens; they can also discuss its applicability with experts simultaneously by telephone. Relevant results can then be post-processed into suitable lookup tables and printed immediately at the requestor's location. The flexible database management capabilities of TIS, its direct interconnection with electronic word processors and typesetters, and electronic mail provide a work environment well suited for the logging of requests for technical information and for recording and/or reporting of ORTA responses.

Under development and in operation since 1975, TIS can be accessed from standard computer terminals by telephone dial-up, WATS lines, TYMNET, and the extensive ARPA computer network.[11,12]

These TIS capabilities and communication links are highly effective when applied to searches for advanced applications of known technological needs. More significantly, post-processing tools under development on TIS permit the tentative identification of technological breakthroughs and innovations that may not be obvious when examined by conventional means.

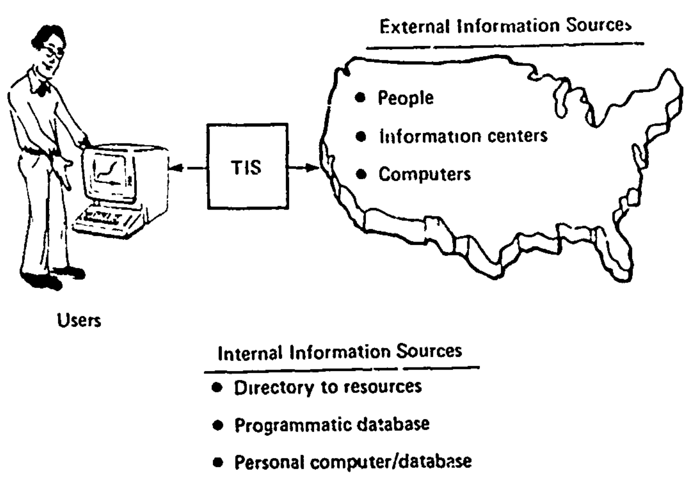
3.1 TIS – An Intelligent Gateway to Technological Resources

The automated and transparent access procedures to different information centers are part of our prototyping of an Intelligent Gateway Computer (IGC). Users of TIS may consult the availability of programmatic technical resources stored internally for their use, or made available to them via TIS on external information sources:

The Technology Information System "TIS"
An Intelligent Gateway Computer

"One does not build a Library by writing books!

"Likewise, to build Information Centers, we must encourage the collection and analysis of available data, by proven techniques and worldwide communications, for the rapid transfer of knowledge."



Each external information center is qualified online on TIS by its accreditation, the availability and cost of its databases, an annotated description of salient commands, and prevailing up-times. This information is extracted by periodic transfer from extended information centers to TIS for online consultation by the TIS user community prior to use, thereby saving time and communication costs. Where appropriate, access to external information resources is granted to TIS users on an individual basis by the Database Administrator. Users gain access to other information centers simply by giving the command CONNECT, followed by the target name of the desired resource: e.g., *CONNECT DOE/RECON12 will establish access to DOE/RECON at 1200 baud.

Alternatively, users may specify the TIS option number of the desired resource, which is part of each online menu. In either case, users need not be familiar with telephone dial-up numbers, accounts, passwords, or peculiar protocols.

User communities of the TIS establish their own views of internal and external programmatic resources, in a self-guided manner, without programmer intervention. Database Administrators assigned to each user community control access rights on a need-to-know basis. Individual users see only those resources (e.g., datafiles, interactive models, graphs, and reports) to which they have access. An exception is the external resources we advertise to promote their use. When a user is finished using a TIS-provided external resource, his access rights can be removed by the TIS Database Administrator, and no change of passwords is required since none were disclosed.

The DIAL command provides an equally powerful, but user-controlled, method for accessing other information centers and computers. In this case, the user is prompted to specify the telephone number, baud rate, parity, and other parameters. TIS then establishes the communication similar to an automated telephone dialer. Here users have to provide their own accounts and passwords for log-in on the external host machine. Such procedures can be saved for personal, routine use.

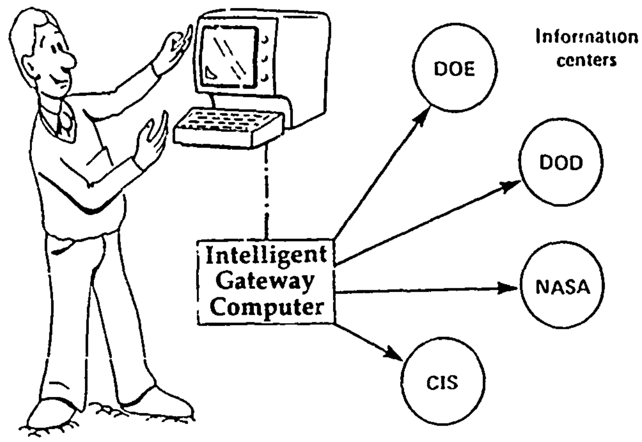
When an account with another information center is opened for TIS, the vendor bills TIS at LLNL, which, in turn, deducts the appropriate costs from the responsible programmatic accounts. When users establish their own accounts with information centers and use them via TIS, they are billed directly by the vendors, who cannot distinguish by what means the user accessed and used their information center.[13]

For the LLNL/ORTA technology transfer program, we established automated access to the TECTRA information system at the School of Business and Public Administration at the California State University in Sacramento,[14] the Agnew Tech-Tran Inc. online translation service,[15] and the DOE patent database at the DOE/RECON information center in Oak Ridge, Tennessee. Some of these files were transferred by electronic means to TIS and installed online for enhanced use by a wider user community. They include;

- *International Technology Transfer Directory* of more than 2200 experts.
- TECTRA newsletter guide to about 300 transferable technologies.
- Online address list to 230 federal laboratories.
- Subject index to more than 2000 DOE patents issued 1975–1982.

Automated procedures to access the technology transfer files of other agencies are in preparation. Individually authorized users of TIS may search the bibliographic information centers of DOE, DOD, and NASA for applicable technologies. The Chemical Information System (CIS) of NIH/EPA, the DARC system in France, and the DECHEMA thermophysical properties system in Germany, among others, may be consulted online for chemical and toxicological information.

The TIS Intelligent Gateway gives users a unified view of available resources without obliging individual information centers to conform to standard command languages or formats. This has the added benefit of inadvertently normalizing dissimilar procedures at different information centers whose staffs are encouraged to view the rendition of their system via TIS, to test the capabilities of others, and to adopt those capabilities that are superior to their own.

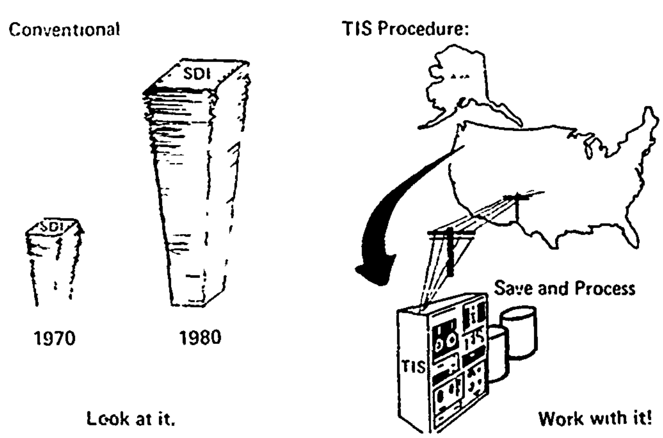


3.2 Downloading of Relevant Information

Most online bibliographic information is still being sold by offline printing following a search. At best, the citations are shown or printed in chronologically reverse order—last publication first. When a comprehensive and retrospective search is carried out, the end-user is faced with piles of printouts containing redundant citations, in different formats, from different vendors. Usually, the returns have no indexes or contents lists, and manual review and organization of the material is required. Much of the information thus received is probably being discarded unused.

To eliminate some of these difficulties, the user of TIS can initiate extraction and downloading of information from another system to TIS in two ways: **First**, the SAVEON option permits extraction of information when used with the CONNECT command discussed previously. In this case, all information seen on the screen during one session is placed into a user-named file.

Post-Processing of Bibliographic Information



Approximately 100 citations with abstracts can be extracted and saved in 10 minutes at 1200 baud by asynchronous telephone dial-up. Faster transmission is possible with 9600-baud dedicated and conditioned synchronous lines. **Second**, the DIAL command permits extraction and downloading into one or more individual, user-named files that can be opened and closed at liberty by special control characters during a session, e.g.

ESCAPE CTRL-A—prompts the user for a file name and saves the viewed information therein. An additional ESC-CTRL-A closes the file. If the file already exists, the new information is appended to permit progressive creation of a cumulative subject datafile.

ESCAPE CTRL-B—sends a local file from TIS to a remote machine. This has particular importance when downloaded and saved information is to be transferred to more powerful computers for analysis, or is to be shared with someone else via TIS.

Other special control characters permit the user to stop the viewing and/or saving of information and to address the local or remote computer selectively.

The legal and monetary implications of downloading and sharing information extracted from other centers must be considered carefully.

3.3 Post-Processing of Bibliographic Information Online

When a retrospective search is conducted for a new field of interdisciplinary research, it is not unusual to obtain thousands of citations from different information vendors, in different formats, with redundant overlap.

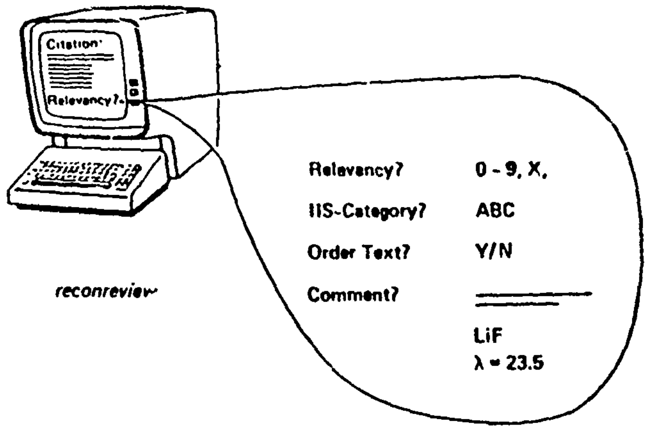
Recently, a request made to the Transportation Systems Research program at LLNL to identify foreign R&D in electric batteries yielded 1.5 ft of printouts from federal and commercial information vendors. The 2000 citations, obtained by conventional means at a cost of about $1700, were quite useless. It was difficult to convey, in time, meaningful statistics, insights, or magnitudes of ongoing R&D abroad to DOE headquarters. The offline prints alone took six days to arrive by mail. One solution to this problem, at least for databases from DOE/RECON, is the post-processing of downloaded citations with TIS.

First, simple TIS commmands save the retrieved information in a convenient, user-defined filing system. This permits results to be organized and aggregated in a suitable manner. Redundant citations can be eliminated by their congruent main data fields, primarily by comparison of authors and titles. Second, the resulting unique set is then reviewed and analyzed online by self-guided, post-processing routines.

- •REVIEW—Citations for relevancy.
- •DISPLAY—Graphs of publication rates.
- •PERMUTE—Multiterm expressions in data fields.
- •CROSS-CORRELATE—Contents of data fields, with statistics.
- •CONCORD—Citations by author, subject, descriptors, etc.

The REVIEW command permits online determination of relevancy. Citations are shown on the screen, reformatted by accentuation and indentation of titles, authors, and abstracts. This renders them more readable than citations commonly offered by information centers. The viewer may keep or discard any citation shown and assign his own category and relevancy code. He may add comments, order the full-length text, and define and fill new data fields for numeric and/or administrative purposes. Retained and annotated citations are saved in new user-named files. Fields defined during the review process can subsequently be used with other fields for post-processing.

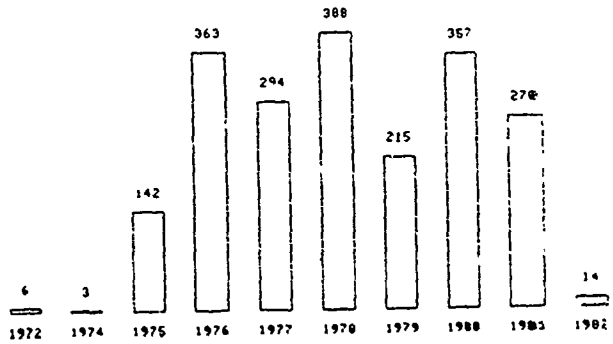
Online Determination of Relevant Set



The DISPLAY of the publication rate for a particular search topic, institute, or author immediately indicates the effort or growth in the field of activity and might well be the first display an end-user wishes to see. In most cases, an apparent decline follows a sharp rise in the publication rate. This decline is predominantly the time lag between the publication of the primary literature and its entry into the secondary online database holdings. To appreciate the actual decrease or increase in publications in a particular field, one has to compare it with the total annual increase in the publication rate. In the sciences, this rate is now about 13%.[16]

Preliminary analysis of patents issued to the former Atomic Energy Agency, the former Energy Research and Development Administration, and the present Department of Energy shows yet unexplained irregularities in recent years and may signal a decline. The decline may be the result of decreased R&D funding in science and technology in the 1970s.

DOE/RECON Data Analysis Program
Number of Publications per Year



The most significant aspect of post-processing is probably the time-dependent change or momentum of a particular field in R&D, derived from the statistics of its permuted descriptive terms. the PERMUTE command of our post-processing routines provides this option by counting the number of times a specified term appears in the message-carrying fields of citations, like the title, abstract, descriptor, category, etc. This is done by analyzing single and compound expressions containing up to four terms (e.g., solar energy conversion experiments). All compound expressions of this type appearing in the selected data fields are presented to the viewer online, alphabetically ordered, with their frequency of occurrence. The following table shows this for the leading descriptors of the 2000 most recent DOE patents.[17]

842	DESIGN
268	FABRICATION
94	SPECIFICATIONS
83	LMFBR TY[illegible] REACTORS
81	ELECTRODES
77	RADIOACTIVE WASTE PROCESSING
67	OPERATION
66	CHEMICAL PREPARATION
66	HIGH TEMPERATURE
65	PRODUCTION
64	EQUIPMENT
64	GASES
63	WATER
52	LASERS
49	COAL
49	METALS
49	SEALS
49	TUBES
47	REMOVAL
47	REPROCESSING
46	HYDROGEN
44	ELECTRONIC CIRCUITS
44	SEPARATION PROCESSES
43	AQUEOUS SOLUTIONS
43	CHEMICAL COMPOSITION
42	CHEMICAL REACTIONS
40	CERAMICS
39	VALVES
38	CARBON DIOXIDE LASERS
38	COAL GASIFICATION
38	CONTAINERS
38	LASER RADIATION
38	LIQUID WASTES
38	MICROSPHERES
37	CATHODES
37	LASER ISOTOPE SEPARATION
36	ALUMINIUM ALLOYS
36	CONTROL SYSTEMS
36	FLUIDIZED BED
36	HYDROGEN PRODUCTION

CROSS-CORRELATIONS of expressions between any two fields of the citations can provide new insight. For example, by cross-correlating authors, we can see at a glance who is working with whom. A cross-correlation of the author field with the descriptor field shows, in alphabetic order, the statistics of indexing terms assigned to the work of a particular person for his entire professional career. When carried out in yearly increments, this routine can be used to judge the change of emphasis with time.

Barlow, T M	11*	Barlow, T M
	1	Burrows, C.R
	2	Chiao, T T
	2	Cornell, E.P
	3	Crothers, W.T
	2	Frank, D.N.
	3	Kulkarni, S.V.
	1	Reimers, E.
	2	Rinde, J.A.
	2	Turnbull, F G.
	31	TOTAL
Bauer, W H	2*	Bauer, W.H.
	1	Brobeck, W.M.
	1	Younger, F.C.
	4	TOTAL
Beachley, N.H.	10*	Beachley, N H.
	1	Dietrich, A.
	9	Frank, A.A.
	1	Harter, R.
	1	Jamzadeh, F
	1	Lau, K.
	1	Otis, D.R.
	1	Stockman, D.
	1	Volz, T.
	26	TOTAL

Author-Author Correlation

Davis, D	1	COMMERCIALIZATION
	2	FLYWHEEL ENERGY STORAGE
	3	FLYWHEEL-POWERED VEHICLES
	4	FLYWHEELS
	3	HYBRID ELECTRIC-POWERED VEHICLES
	1	OPERATION
	2	PERFORMANCE TESTING
	3	PERFORMANCE
	25	TOTAL Descriptors
General Electric Co., Schenectady, NY(USA) Corporate Research and Development Dept	1	COMPUTER CALCULATIONS
	1	COMPUTERIZED SIMULATIONS
	2	CONTROL EQUIPMENT
	1	COST BENEFIT ANALYSIS
	2	DESIGN
	1	ELECTRIC GENERATORS
	1	ENERGY STORAGE SYSTEMS
	2	EXPERIMENTAL DATA
	2	FABRICATIONS
	3	FEASIBILITY STUDIES
	3	FLYWHEEL ENERGY STORAGE
	4	FLYWHEEL POWERED VEHICLES
	1	FLYWHEELS
	3	HYBRID ELECTRIC-POWERED VEHICLES
	1	LIFE CYCLE COST
	2	PERFORMANCE TESTING
	2	RESEARCH PROGRAMS
	1	STEELS
	1	WELDING
	34	TOTAL Descriptors

Author-Descriptor Correlation

CONCORDANCES generated by author, descriptor, corporated author, or country yield succinct listings of bibliographic citations in a particular field. These alphabetical indexes are similar to those commonly produced as lookup tables for authors or subjects. In this case, they are created at the pleasure of the user, online, on the contents of any citation field. The following table shows an extract from our forthcoming concordance of DOE patents. It will provide a convenient list of patents available for licensing in different fields of technology.

Extracts from Concordances of DOE Patents by Author and Descriptor.

Erdal, B R			
1975	Grant, P M., Erdal, B R . O'Brien, H A	RUBIDIUM RADIOISOTOPE GENERATOR	77P0069342
1976	Grant, P.M . Erdal, B.R . O'Brien, H A	Sr^{82}-Rb^{82} RADIOISOTOPE GENERATOR	77P0019544
Essebaggers, J			
1975	Essebaggers, J	ENERGY ABSORBER FOR SODIUM-HEATED HEAT EXCHANGER	76P0058174
Evans, H W			
1976	Evans, H W	PROTECTIVE AIR LOCK	76P0076192
Eveileigh, J W			
1976	Sartory, W K.; Eveileigh, J.W.	CENTRIFUGE APPARATUS	77P0007759
Farnum, E H			
1975	Farnum, E H . Fries, R.J	METHOD FOR SIZING HOLLOW MICROSPHERES	77P0040417
1976	Farnum, E H ; Fries, R.J.	METHOD FOR NONDESTRUCT-IVE FUEL ESSAY OF LASER FUSION TARGETS	77P0085122
Farrior, W L Jr			
1976	Farrior, W.L. Jr.	REGENERABLE SORBENT AND METHOD FOR REMOVING HYDROGEN SULFIDE FROM HOT GASEOUS MIXTURES	77P0085122

COAL DEPOSITS			
1976	Archibald, P.B.	EXPLOSIVE FLUID TRANSMITTED SHOCK METHOD FOR MINING DEEPLY BURIED COAL	77P0005251
1976	Fisher, S.T.; Fisher, C B.	EXTRACTION OF HYDROCARBONS IN SITU FROM UNDERGROUND HYDROCARBON DEPOSITS	77P0005129
1976	Pasini, J. III; Overbey, W.K. Jr.	METHOD FOR REMOVAL OF METHANE FROM COALBEDS	76P0063102
COAL FINES			
1976	Coates, R L	GASIFICATION OF CARBON-ACEOUS SOLIDS	77P0085185
COAL GASIFICATION			
1976	Coates, R.L	GASIFICATION OF CARBON-ACEOUS SOLIDS	77P0085185
1976	Donath, E.E.	METHOD AND APPARATUS FOR REMOVING COARSE UNENTRAINED CHAR PARTICLES FROM THE SECOND STAGE OF A TWO-STAGE COAL GASIFIER	76P0062836
1976	Fisher, S.T.; Fisher, C.B	EXTRACTION OF HYDROCARBONS IN SITU FROM UNDERGROUND HYDROCARBON DEPOSITS	77P0005129
1976	Komar, C A.	METHOD FOR CONTROL OF SUB-SURFACE COAL GASIFICATION	77P0085189
1976	Lee, B S	OXIDATION OF COAL WATER SLURRY FEED TO HYDROGASIFIER	77P0005121

Output from post-processing routines can be saved in files for subsequent use or for transfer to electronic word processors and merging with reports, or it can be sent to typesetters as camera-ready copy for publication. It can also serve as input to online data files for interactive use. A description of present TIS post-processing capabilities has been published.[19]

These post-processing and text analysis techniques have a direct bearing on technology transfer programs by packaging their descriptive information in a comprehensive, well-organized manner for quick lookup. For those without direct access to TIS, we generate the information by machine for printing or for use as microfiche. For example, the descriptive concordance of 2000 patents issued to DOE and its predecessors since 1975 amounts to an alphabetic index of 3300 descriptive terms from the DOE/RECON/INIS thesaurus on 1000 pages of print, or about 12 microfiche with a 24× reduction.[18]

3.4 Finding Pearls in the Mire

Until now we have discussed the rendition of technical information in response to desired advanced applications in known fields of interest. Of potentially much greater significance is the filtering of the large volume of technical information to expose those citations that may signify potential breakthrough and discovery. This will become crucial as we approach the 1980s and are faced with ever larger volumes of factual data each year. To increase our national productivity, we must establish procedures to filter the data and to recognize creative publications quickly.

One approach is to filter out those publications in a general technological category that deviate from previous norms by inspecting the single and multiterm expressions used by authors in titles and abstracts, and/or the use of descriptors by indexers. This type of text analysis, although not new, has some fascination because it permits us to recognize significant migration or cross-fertilization of new ideas in R&D work.

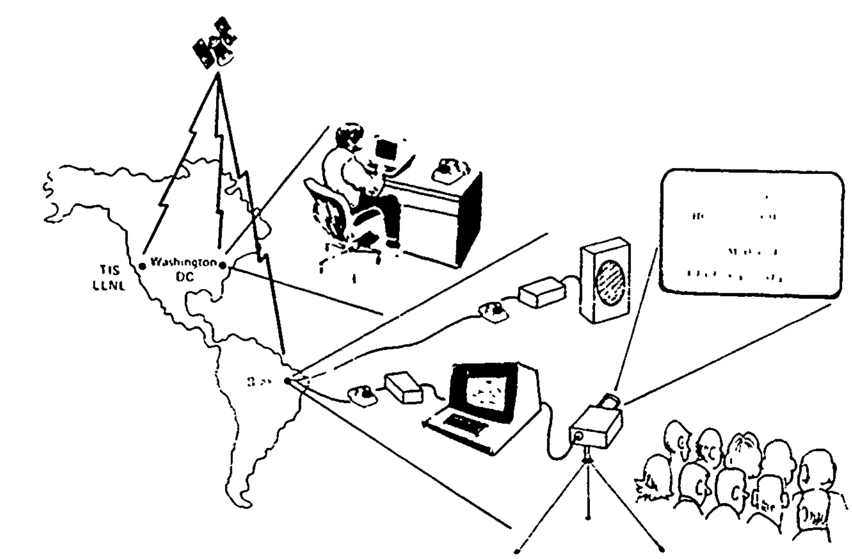
Take the laser field, for example. When one creates an authority list of all single and multiterm expressions derived from titles and abstracts, one arrives at a reasonably stable, slowly changing body of descriptive terms. Newly appearing terms can easily be set aside and used to mark citations for closer inspection. It is thus possible to find the citation where laser beams were first used to weld the *retina* in an eye. In other words, one can filter out those citations that somehow do not follow the common pattern of previous descriptive indexing or word usage. They contain either typographical errors or, potentially, technological pearls. Other examples quickly come to mind. The techniques for doing this type of analysis have been known since the time inverted tables, or secondary indexes, were introduced for the machine-aided lookup of facts. They could be used in the 1980s as a new means of SDI service, signaling unusual and different publications, or discovery ready for advanced applications.

The extraction of intelligence from the literature in science and technology and its rapid application in industry is expected, if adequately supported, to have far-reaching effects on our economy. The recent impetus given to the technology transfer program as a nationally mandated activity will hopefully permit the development of advanced pattern-recognition techniques for text and data analysis.

3.5 Linking the Technology Requestor with the Expert

Users of the TIS Intelligent Gateway can link their terminals to those of others logged in on the machine. Requestors of information may thus work jointly from their terminals with experts while searching for technological information on a distant information system in this country or abroad

The effectiveness of this TIS procedure was demonstrated by the NASA Industrial Applications Center (NIAC) at the University of Southern California earlier this year when their information specialists conducted searches on DOE/RECON, NASA/RECON, and other information centers by joint viewing and telephone discussion of results with clients elsewhere in the country.[20] These tests were made in



Simultaneous graphical display and voice communication!
Terminals of expert and student(s) are equivalent!

preparation for more-extensive evaluations planned under the auspices of the Small Business Administration with NASA-NIAC-USC and clients in Idaho. The immediate post-processing of retrieved results and the printing of relevant information at the clients' terminals was shown to save time and money. This methodology can also be used for nationwide tutorials and class instruction.[21]

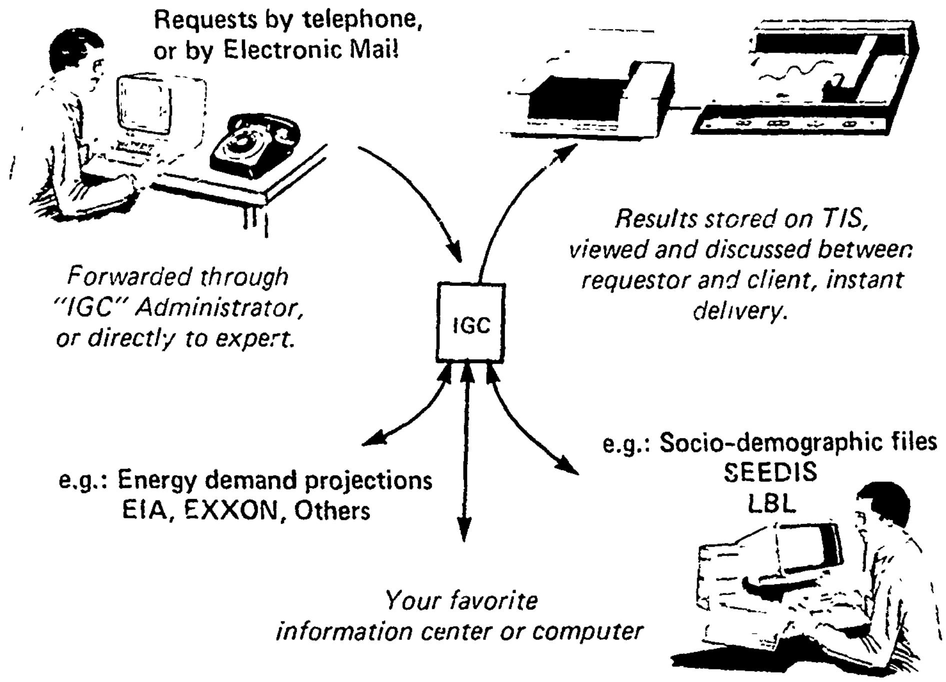
In a transcontinental demonstration last Decemeber, Dr. C. Sullivan, via TIS, gave a tutorial on the use of the Chemical Information System to a class of 48 professionals at the University of Ouro Preto, Brazil, without leaving his desk in Washington, D.C. Participants in this training couse on database management in the geosciences, under sponsorship of the United National General Information Program (UNESCO/PGI), heard his voice and saw the search strategies and chemical structures projected on the screen of their auditorium. They could ask questions and try new skills under Dr. Sullivan's guidance. Arrangements for this tutorial had been made the day before from Brazil.[21]

3.6 The Intelligent Gateway Computer as an Intermediary to Technical Information

Audio-visual linking of users across nations and continents suggests, in a general sense, a new application of the TIS Intelligent Gateway Computer (ICG) as an electronic intermediary between requestors and vendors of technological information. Another decade may go by before administrators feel comfortable using their own computer terminals. Even then, it will probably be more efficient for the infrequent computer user to unburden his mind with requests for technical information by asking a staff assistant or secretary to send the requests by electronic mail or, even better, to dictate them directly into a message machine.

We have implemented these capabilities on the IGC prototype by making the telephone number for the message machine reserved for this purpose known to our users, by the REQUEST command, and by extensive electronic mail capabilities that permit us to forward and answer mail, including reports and graphs, in an automated manner. We envision increased use of this capability in future months by forwarding such requests through the TIS Database Administrator to the experts, with appropriate annotations concerning the delivery time and the requestor's willingness to pay. The results would then be

"ICG – A Practical Intermediary to Expert Information"



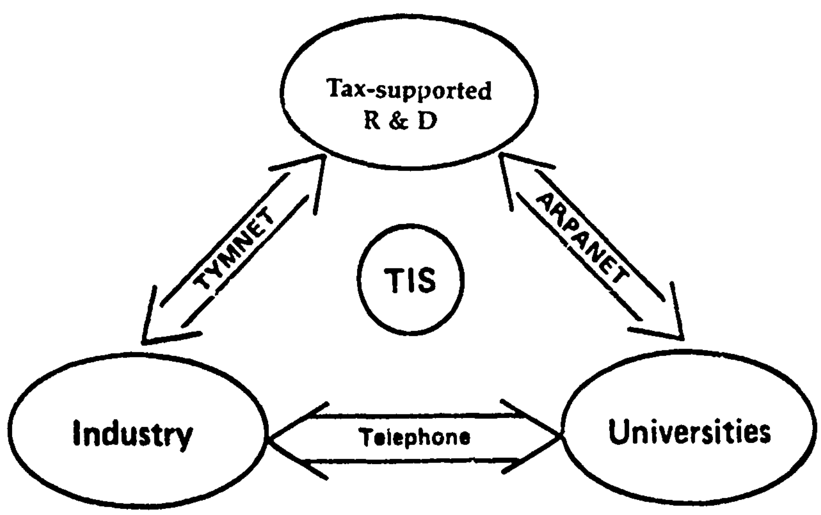
returned to the requestor's ICG mailbox, for joint discussion with the expert if necessary or for immediate printing at the requestor's facility. The TIS Intelligent Gateway Computer will thus become the electronic intermediary between the end-user and the information expert.[23,24]

Conclusion

Advanced capabilities in information management and communications, under development for the IGC on the TIS at LLNL, are being used to establish a focal point for the technology transfer community. Dissimilar and geographically distributed technological resources can thus be viewed and used as an integrated system and provide a cost-effective means for the exchange and sharing of information among federal laboratories and technologists at universities and in industry. This is expected to contribute to successful implementation of the Stevenson–Wydler Technology Innovation Act and to enhance productivity in the United States.

Concerns have been expressed that the collection and persuasive presentation of well-organized technical information could also be acquired by other countries. Its use by developing countries, who struggle in the marketplace for their fair share of rewards, should prove to be mutually beneficial. The situation is different when we question the transborder flow of advanced technologies to countries who compete with us both economically and politically. The Information Science and Technology Act (H.R. 3137[26]) and Section 38A of the *Control of Export of Arms Information* address themselves to both issues.

A definitive, practical policy for the role of government in the evaluation and dissemination of numeric data in science and technology is much needed. Whatever the outcome, it is of paramount importance that we learn to be the *first* to apply the technology we develop.



Acknowledgments

Robert Tap, Director of the Information System Division, Transportation Systems Center, Department of Transportation (DOT-TSC), specified in 1975 the functional requirements for a transaction controller that could serve as an automated gateway for DOT system analysis. This resulted in the Monitor of Distributed Data System (MODDS)[27] and laid the foundation for work later continued by the Department of Energy.

The TIS owes its beginning to the foresight and technical judgment of George F. Pezdirtz, then Director of the DOE Division of Energy Storage. He recognized years in advance that information science and communications technology were on converging paths and that this merger could be directed toward faster and better access to information communications among administrators and R&D personnel of national programs. This organization, the present Office of Energy Systems Research (DOE/ESR) has been the prime sponsor of TIS. More recently, the DOE Technical Information Center (DOE/TIC) has, with assistance from other agencies, been funding development of the Intelligent Gateway Computer.

The staffs of Control Data Corporation, Jeff Schriebman Consulting, and Scott Consulting have contributed their unique expertise and talents to the project.

Lawrence G. O'Connell, Manager of the Transportation Systems Research program at LLNL, has fostered the development of the TIS since 1979. Here TIS is used as a practical and useful tool for cross-country information management in support of electric vehicle research, the aluminum-air mechanically refuelable electric battery, inductively-coupled hybrid electric vehicles, and transportation systems analysis.

This report was expertly designed by our Word Processor Specialist, Gayle DeLaurentis.

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